Conceptual Review:

- Ways to change momentum ($\bar{p}$) and impulse ($\bar{J}$):
  1) change velocity
  2) change mass
  3) change force
  4) change time

$$\bar{J} = \Delta\bar{p} = (\bar{p}_f - \bar{p}_i)$$
$$\| \quad \| \quad \|$$
$$\bar{F}\Delta t = m\Delta\bar{v} = m(\bar{v}_f - \bar{v}_i)$$

When do collisions cause the highest force?

hit, both stop

hit, one bounces back, one stops

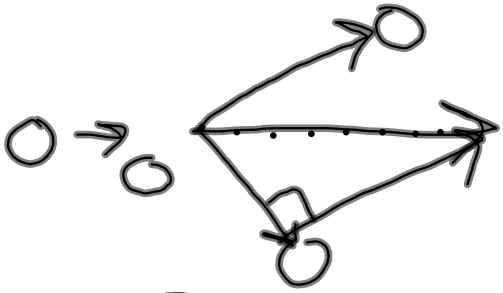
hit, both bounce back

Problem Types:

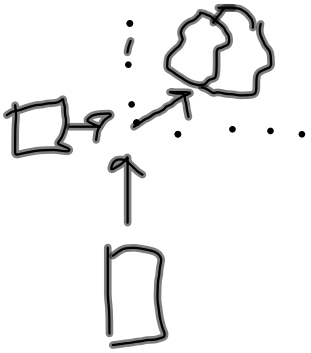
- Impulse-Momentum
  - 1-D:
    - Elastic
    - Inelastic → hit/stick
    - Inelastic → together/apart

eqns. on equation sheet

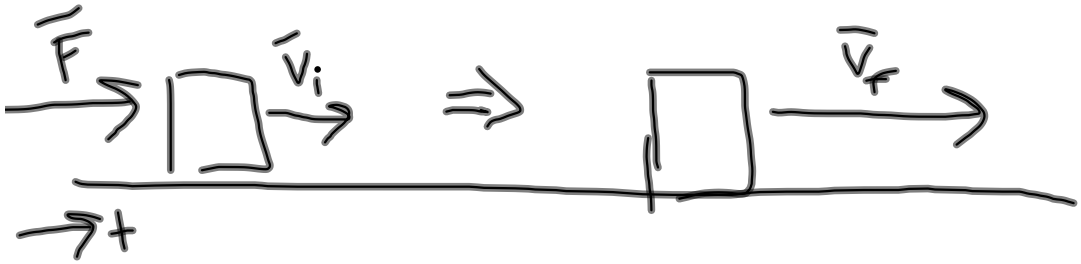
  - 2-D:
    - Elastic



    - Inelastic



A 25 N force is applied to a box for 10 s. It has a mass of 10 kg, and had an initial velocity of 4 m/s. What is the box's final velocity after the 10 s?



$\bar{F} = 25\,N \quad \bar{v}_i = 4\,m/s \quad \bar{v}_f = ?$

$\Delta t = 10\,s \quad m = 10\,kg$

$$\bar{F}\Delta t = m\Delta\bar{v} = m(\bar{v}_f - \bar{v}_i)$$

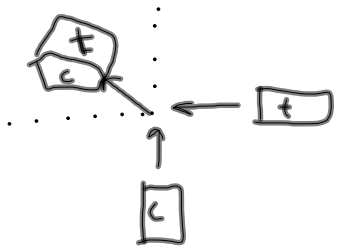
$$v_f - v_i = \frac{F\Delta t}{m}$$

$$v_f = \frac{F\Delta t}{m} + v_i$$

$$= \frac{(25\,N)(10\,s)}{10\,kg} + 4\,m/s$$

$$= 29\,m/s$$

A car traveling north at 40 m/s with a mass of 2200 kg collides and stikks to a truck traveling west at 28 m/s with a mass of 3100 kg. What is their final velocity after the collision?



X-direction: $\bar{P}_{fx} = \bar{P}_{ix}$

$= \cancel{\bar{P}_{cix}}^{\,0} + \bar{P}_{tix}$

$= m_t \bar{v}_{tix}$

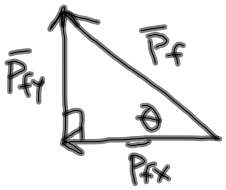
$= 86800 \text{ kg}\cdot\text{m/s}$

y-direction: $\bar{P}_{fy} = \bar{P}_{iy}$

$= \bar{P}_{ciy} + \cancel{\bar{P}_{tiy}}^{\,0}$

$= m_c \bar{v}_{ciy}$

$= 88000 \text{ kg}\cdot\text{m/s}$



$P_f^2 = P_{fx}^2 + P_{fy}^2$

$P_f = 123605 \text{ kg}\cdot\text{m/s}$

$\theta = \tan^{-1}\left(\frac{P_{fy}}{P_{fx}}\right)$

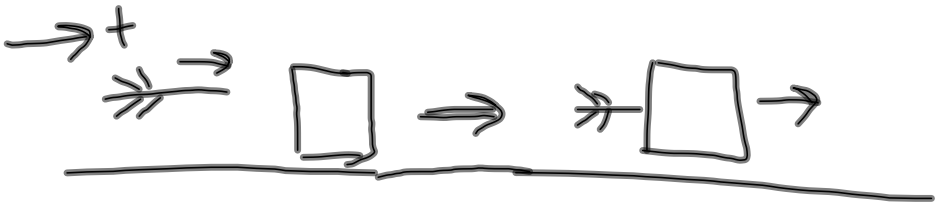
$= 45.4°$

$\bar{V}_f = 23.3 \text{ m/s} @ 45.4° \text{ N of W}$

$\bar{P}_f = m_{total} \bar{V}_f$

$V_f = \frac{P_f}{m_c + m_t} = 23.3 \text{ m/s}$

A dart hits and sticks in a block of wood ($m = 10\ kg$), and they slide together at a velocity of $8\ m/s$. If the dart has a mass of $0.605\ kg$, what was the dart's initial velocity?
(Block initially at rest)



1-D inelastic hit/stick

d = dart
b = block

$$m_d \bar{V}_{di} + m_b \bar{V}_{bi} = (m_d + m_b)\bar{V}_f$$

$$V_{di} = \frac{(m_d + m_b)V_f}{m_d}$$

$$= \frac{(.605\ kg + 10\ kg)(8\ m/s)}{.605\ kg}$$

$$= 140.2\ m/s$$